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# REPORT TO THE
# COMMITTEE ON APPROPRIATIONS
# OF THE
# UNITED STATES HOUSE OF REPRESENTATIVES

# CALS

## COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT


## OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
## (PRODUCTION AND LOGISTICS)

**WASHINGTON, D.C.**
**JULY 31, 1988**

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# EXECUTIVE SUMMARY

## COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS)

### OVERVIEW

Widespread use of computer-aided design and engineering (CAD/CAE) has created a new environment where product description data is becoming available in digital form to support a wide range of DoD and Industry applications. CALS is a DoD and Industry initiative to enable and accelerate the use and integration of this digital technical information for weapon system acquisition, design, manufacture and support. Through management of the CALS program, a comprehensive strategy has been developed to facilitate the transition from the current paper-intensive mode of operations to a highly automated and integrated mode, thereby substantially improving productivity and quality of the weapon system acquisition and logistics support process. Implementation of CALS is underway and is already leading to a major impact on the way DoD and Industry conduct business.

### OBJECTIVES AND BENEFITS

The Deputy Secretary of Defense initiated the DoD CALS program in September 1985, with the goal that by 1990 new weapon systems would start to acquire technical data in digital form (rather than paper) from contractor integrated data bases. Substantial quality improvements and cost reductions are expected, including:

- Reduced acquisition and support costs for weapon systems programs through elimination of duplicative, manual, error-prone processes.
- Improved quality and timeliness of technical information for support planning, procurement, training, and maintenance, as well as improved reliability and maintainability of weapon system designs through direct coupling to CAD/CAE processes and data bases.
- Improved responsiveness of the industrial base by development of integrated design and manufacturing capabilities, and by Industry networks to build and support weapon systems based on digital product descriptions.

## STRATEGY

To achieve CALS benefits, a phased strategy has been planned by a team composed of Office of the Secretary of Defense (OSD), the Military Services, the Defense Logistics Agency (DLA), and Industry. Phase I will replace paper document transfers with digital file exchanges and begin process integration, and will be implemented between now and the early 1990s. In parallel, technology is being developed for Phase II, which involves substantial redesign of current processes to take advantage of a shared data base environment in the early 1990s and beyond. The main roles of DoD in both phases are:

- Accelerate the development and testing of data interchange and access standards,
- Fund technology development and demonstrations in high-risk areas,
- Encourage Industry investment in integrated processes by establishing contract requirements and incentives, and
- Implement CALS capabilities in DoD's own extensive automated systems.

Defense industry representatives have been involved from the outset in planning the implementation of this strategy.

## STATUS

In the first two and a half years of the program, OSD, the Services, and DLA have established CALS offices, published CALS plans, and started implementation. Progress to date includes:

Standards. Rapid progress has been made in developing standards for digital data interchange and access, and in building Industry support for their use. CALS standards are implementations of existing or emerging national and international industry standards. The initial set of CALS standards was published for DoD use in December 1987. The standards support the delivery of engineering drawings and technical manuals in digital form. DoD's interagency agreement on CALS with the National Bureau of Standards provides for the development of a comprehensive set of standards and specifications, with annual additions to the initial set planned through 1990. Under Air Force lead, a CALS testing network which includes DoD and Industry nodes will start operation in 1988 to evaluate the CALS standards in user applications. DoD is now ready to implement these standards in contracts that will deliver data in the early 1990s.

Technology. The technology for Phase I of CALS is being demonstrated in a number of Service test bed programs. Examples include paperless technical manual systems, development and integration of CAD/CAE based reliability design tools, on-line access to government and commercial parts data libraries, and automated development and presentation of technical manuals and training material. For Phase II, an industry-funded cooperative venture has been formed to accelerate development and implementation of advanced product data exchange standards. Several government sponsored research and development projects in integrated product data bases are being coordinated and focused through CALS to complement Industry development efforts. One major development target is to use digital data to drive flexible automated manufacturing processes that will significantly reduce spares production lead times.

Weapon System Application. Several programs have already begun trial applications of CALS technologies and integration approaches. CALS pilot programs include the A-12, ATF and LHX aircraft (coordinated under the Joint Logistics Commanders), the V-22 aircraft and the SSN-21 submarine. These programs provide demonstrations of data integration, on-line government access to contractor maintained data, and digital data interchange. Successfully demonstrated approaches will be used on these programs and others in the early to mid 1990s.

To support routine use of the new CALS standards, a draft implementation guide for DoD acquisition managers is now in coordination. Policy has been issued to require requests for proposals for new weapon systems to obtain proposals for CALS data integration, access, and delivery starting in October 1988, and to review existing contracts for cost or quality improvement opportunities that would result from retrofit of CALS requirements.

DoD Systems. For weapon systems that are entering development in 1988 to be able to contract for digital data delivery, DoD receiving systems must be in place in 1990-1995. The Services and DLA have made a commitment to implement CALS integration requirements and standards in DoD infrastructure systems. This will provide a common interface to Industry. The three highest priority areas are:

- Architectural planning to link DoD islands of automation and interface with Industry
- Equipping automated engineering data repositories with capability for digital input to support spares procurement and sustaining engineering
- Providing for digital input to automated publishing and paperless technical manual systems.

Actions this year for the DoD infrastructure include approval of the Army CALS architecture program to proceed with concept development, activation of automated repositories jointly procured by the Army and Air Force, source selection and planned contract award for a joint

Navy/DLA procurement of automated repositories; and Air Force approval of an infrastructure program for electronic technical manuals using the CALS standards.

Industry Involvement. Substantial Industry momentum and enthusiasm have been generated for CALS, and DoD-Industry cooperation has been exemplary. Industry advocates have used DoD's commitment to CALS to gain internal management backing for investments in automation and integration of diverse processes. A voluntary CALS Industry Task Force has attracted over 300 members who have been extremely active in developing and coordinating CALS standards, defining integration requirements and addressing acquisition issues.

## FUNDING

The DoD CALS budget for fiscal year 1989 totals $120 million for technology development, demonstration and infrastructure modernization and planning projects. This budget includes $45 million for projects initiated since 1985 in direct response to the CALS initiatives, as well as $75 million for ongoing technology and infrastructure modernization programs under the DoD CALS Steering Group oversight. These CALS projects are leveraging both the multi-billion dollar DoD plans for overall infrastructure modernization and an even larger investment in Industry for information and automation systems.

## SUMMARY

The CALS program has made significant progress during the past year. The publication of the initial set of technical information exchange standards represents a major CALS milestone accomplishment. A standards application testing program has begun and initial applications to weapon systems are being demonstrated. In addition, the incorporation of CALS concepts into DoD and industrial infrastructures is underway and advanced technology to meet long term CALS requirements is being accelerated through close DoD and Industry collaboration.

CALS provides a unique opportunity to achieve major productivity and quality improvements through carefully planned and managed investment by both Government and Industry. Initially, the changes will be gradual, as building blocks are put in place and specific portions of the weapon system life cycle are enhanced.

As the cumulative impact of CALS integration and infrastructure modernization is realized in DoD and Industry, more far-reaching changes will occur in the way functions are accomplished, leading to additional major savings. CALS implementation will result in a lower weapon system life cycle cost, shortened acquisition times, and improvements in reliability, maintainability and readiness.

# COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS)

## 1. BACKGROUND

### 1.1 PURPOSE

This report responds to House Appropriations Committee interest in the Computer-aided Acquisition and Logistic Support (CALS) program as required by House Appropriations Committee report 100-410, page 20. The following report documents the CALS program goals, objectives, strategy, benefits, management and funding. In addition, accomplishments since the last report to Congress in June 1987 and CALS plans for the upcoming years are provided.

### 1.2 CALS OVERVIEW

CALS is a DoD and Industry initiative to enable and accelerate the integration and use of digital technical information for weapon system acquisition, design, manufacture and support. The CALS program will facilitate the transition of current paper-intensive processes to a highly automated and integrated mode of operation, thereby substantially improving productivity and quality of the weapon system acquisition and logistic support process. The Deputy Secretary of Defense initiated the DoD CALS program in September 1985, with the goal that by 1990 new weapon system acquisitions would acquire technical data in digital form or obtain government access to contractor integrated data bases in lieu of paper deliverables. The benefits expected from CALS implementation include:

- Reduced acquisition and support costs for weapon system programs through elimination of duplicative, manual, error-prone processes.
- Improved quality and timeliness of technical information for support planning, reprocurement, training, and maintenance, as well as improved reliability and maintainability of weapon system designs through direct coupling to computer-aided design and engineering processes and data bases.
- Improved responsiveness of the industrial base by development of integrated design and manufacturing capabilities and by Industry networking among prime contractors and subcontractors to build and support weapon systems based on digital product descriptions.

Both DoD and Industry are investing in the automation of a variety of functional areas to improve productivity and quality. Through CALS the

existing islands of technical data automation within DoD and Industry are being integrated to facilitate data exchange and access, as well as to reduce duplication of data preparation effort. Industry has endorsed the action DoD has taken in CALS and the transition to an automated integrated environment has begun.

### 1.2.1 Strategy

To achieve CALS benefits, a phased CALS strategy has been established by a team consisting of Office of the Secretary of Defense (OSD), the Services, Defense Logistics Agency (DLA) and Industry. Phase I will replace paper document transfers with digital file exchanges and begin the integration process, and will be implemented between now and the early 1990s. In parallel, technology is being developed for Phase II which involves substantial integration and redesign of current processes to take advantage of a shared data base environment in the early 1990s and beyond. The main elements in both phases are:

- Standards. Accelerate the development and testing of standards for digital technical data interchange and integrated data base access,

- Technology Development and Demonstration. Sponsor the development and demonstration of the necessary technology for integration of technical data and processes in high-risk areas,

- Weapon System Contracts and Incentives. Implement CALS standards in weapon system contracts and encourage Industry modernization and integration,

- DoD Systems. Implement CALS standards and integration requirements in DoD planning and infrastructure modernization programs. Infrastructure is the underlying framework of organizations, systems and processes within which DoD operates.

### 1.2.2 Scope

CALS encompasses the generation, access, management, maintenance, and distribution of technical data in digital form for the acquisition, design, manufacture, and support processes. Within CALS, the common thread is technical data which includes engineering drawings, product definition and logistic support analysis data, technical manuals, training materials, technical plans, reports and operational feedback data associated with weapon systems, equipment and ships. The scope of the CALS effort in each of the four main strategic elements is summarized

below. Highlights on progress in each of these areas is presented in Section 2 of this report.

- Standards. The standards being developed by CALS are DoD implementations of existing and emerging national and international standards for interchange of text and graphics and for data base definition and access. CALS applications will make use of communications standards developed outside the CALS program. Computer hardware, operating programs and language standards are also outside the scope of CALS. CALS standards are listed in Appendix A.

- Technology Development and Demonstration. The technology associated with CALS includes the development of advanced product data modeling techniques, development and integration of computer-aided reliability and maintainability engineering design techniques, and demonstration of CALS technology in user applications such as electronic technical manuals and parts data access. Appendix B includes a description of key CALS technology projects.

- Weapon System Contracts and Incentives. CALS includes requirements for the integration of weapon system contractor data bases and processes for design, manufacturing, and support; authorized access to contractor maintained data bases by government users (and vice versa); and digital delivery of technical information into the DoD infrastructure systems. Lead weapon system applications are described in Appendix C.

- DoD Systems. DoD infrastructure systems associated with CALS include those systems for which the primary purpose relates to generating, accessing, managing, maintaining and/or distributing technical data. Systems which meet this criterion are described in Appendix D and include engineering data repositories, computer-aided design and engineering systems, and electronic technical manual systems, as well as the system integration/architecture programs which connect CALS related systems and other systems within DoD and with Industry.

## 1.3 CALS RELATIONSHIP TO LOGISTICS ADP MODERNIZATION

DoD's Logistics ADP Modernization Plan is being prepared by the Office of the Assistant Secretary of Defense (Production and Logistics). This plan will document the overall objectives and management of DoD acquisition and logistics systems. A major subset of this plan will include DoD CALS infrastructure systems which relate to technical data. The DoD CALS Office responsibilities for CALS infrastructure systems are outlined in Section 1.4.

## 1.4 CALS MANAGEMENT

DoD and Industry have established an effective organization for planning, managing and implementing CALS. Key organizations and functional area assignments for CALS are depicted in Figure 1. The specific roles of the DoD CALS Steering Group, DoD CALS Office, the DoD Components and Industry are described in the following paragraphs.

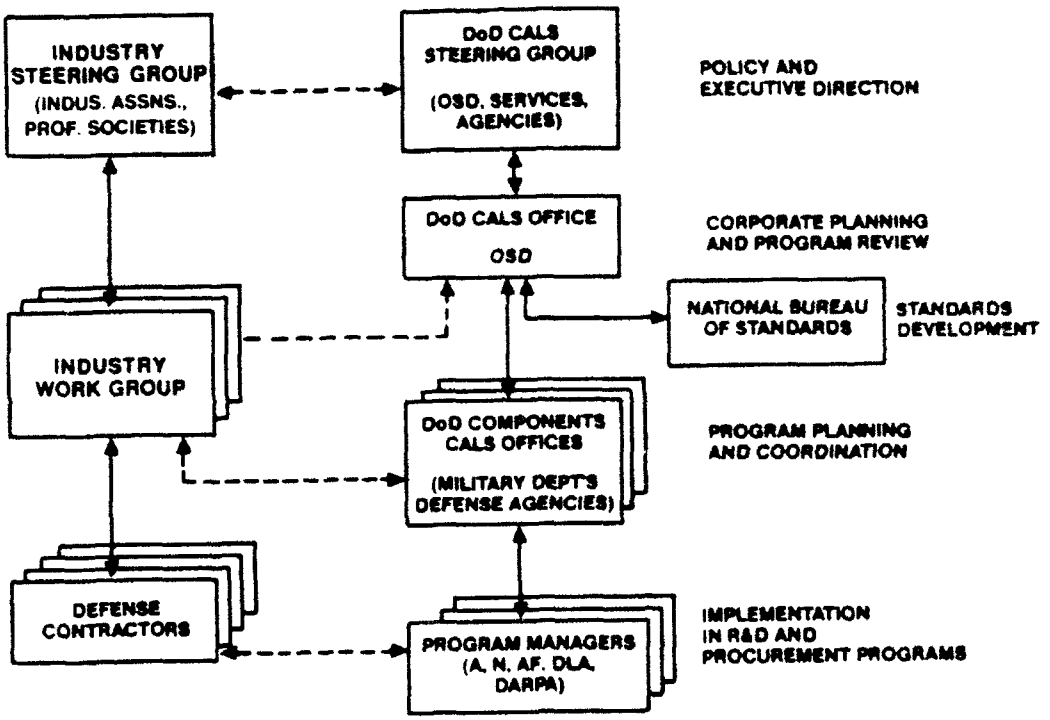


FIGURE 1. CALS MANAGEMENT ORGANIZATION

### 1.4.1 DoD CALS Steering Group Role

The DoD CALS Steering Group serves as the "corporate board of directors" in formulating CALS policy and implementing the CALS program within DoD. It is chaired by the Assistant Deputy Assistant Secretary Defense (Systems) and composed of senior representatives from each of the Military Departments, Defense Logistics Agency, Defense Communications Agency and participants from key OSD organizations including Logistics, Production Support, Procurement, Information Resources Management, and Command, Control and Communication Information Systems. Work groups are appointed by the steering group to facilitate the coordination process.

### 1.4.2 DoD CALS Office Role

The CALS Office within OSD provides planning and implementation guidance and performs the following functions:

- Develops DoD CALS corporate plans, policies, and priorities for CALS implementation
- Accelerates the development, testing, and implementation of standards for digital technical data interchange and product definition
- Ensures interoperability among the DoD Components' technical data systems
- Sponsors and coordinates technology development and demonstrations for integration of technical data and processes
- Ensures an effective Government/Industry interface.

DoD has entered into an Interagency Agreement with the National Bureau of Standards, Department of Commerce, to coordinate the development of data exchange and access standards and conformance tests in cooperation with Industry. In addition, the CALS Office has established a planning group to coordinate DoD plans and oversee architecture design.

### 1.4.3 DoD Components Role

The Military Departments and the Defense Logistics Agency, collectively referred to in this report as the DoD Components, are responsible for implementing CALS policies and priorities established by OSD. Each Component has established a CALS organization for managing CALS initiatives. The Components' responsibilities are:

- Implement CALS policies in coordination with other DoD Components
- Test CALS standards in prototype applications
- Develop and demonstrate technology required for future CALS implementation
- Incorporate the technical data interchange and integration standards and requirements in contracts
- Participate in joint programs and serve as lead Service/Agency as designated by OSD

- Plan, integrate and implement CALS technologies in DoD Component modernization projects.

### 1.4.4 Industry Role

Industry participation is integral to the success of CALS. An Industry Steering Group provides the focal point for CALS planning, technology, and implementation concerns within Industry. Their charter includes:

- Coordinate Industry planning actions with DoD, Industry associations and professional societies
- Participate with DoD in CALS standards and technology development and review
- Provide a forum for promoting Industry management awareness and education about CALS
- Ensure an effective Industry/Government interface
- Recommend acquisition and investment approaches and policy modification.

The Industry Steering Group coordinates activities of the CALS Industry Task Force, which is hosted by the National Security Industrial Association (NSIA). Membership includes the Aerospace Industries Association (AIA), the Electronic Industries Association (EIA), the National Computer Graphics Association (NCGA), Society of Logistics Engineers (SOLE), Institute of Cost Analysis (ICA), the Shipbuilders Council of America (SCA), and others. A complete set of committees and organizational structure is shown in Figure 2. The Industry Task Force has grown to over 300 active volunteer members with involvement in a wide variety of technical and business issues. Within the last year, three new committees were established to focus on acquisition issues, international issues, and education/public communications.

Most recently, Industry has formed an Industry funded cooperative to accelerate the development of the Product Data Exchange Specification (PDES) which is central to Phase II CALS. A Government PDES Users Group has been established under the DoD CALS Steering Group to interface with the cooperative. This users group has representation from DoD, National Aeronautics and Space Administration, Department of Energy, and Department of Commerce/National Bureau of Standards.

In addition to the support being provided through the Industry Steering Group and Task Force, individual companies are now incorporating CALS objectives and methodologies into their internal system integration and modernization efforts.

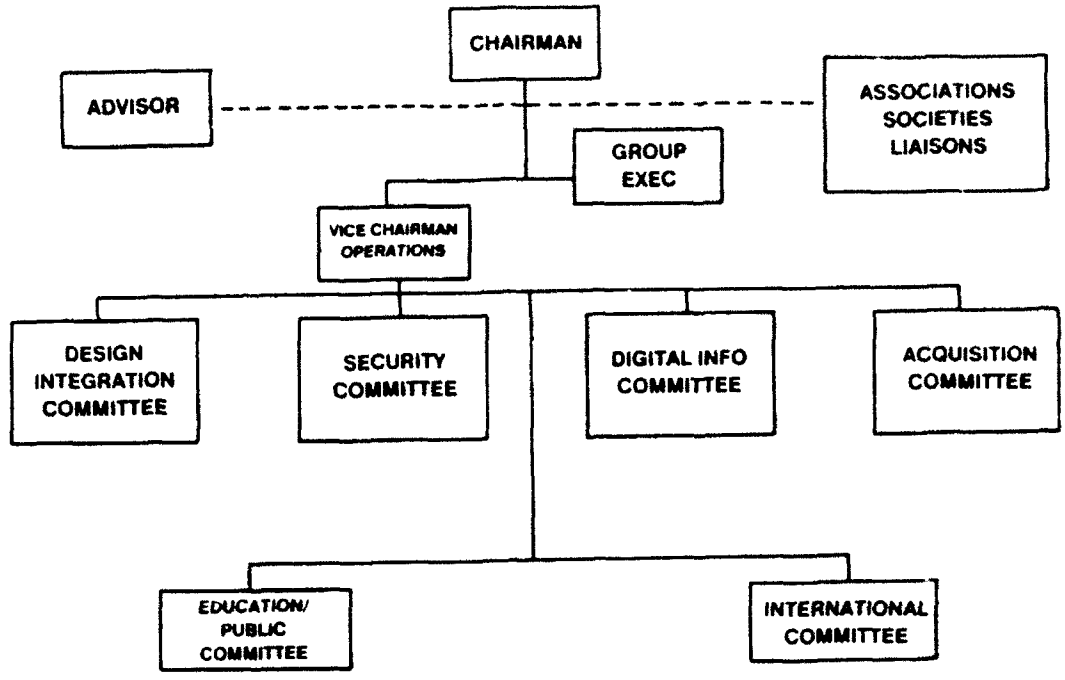


**FIGURE 2. INDUSTRY STEERING GROUP**

## 1.5 CALS BENEFITS

DoD and Industry are beginning to experience the productivity and quality benefits of CALS. The momentum and enthusiasm associated with the entire CALS initiative have been effective in getting CALS projects implemented in several major weapon system programs.

Substantial quality improvements and reductions in acquisition and support costs are expected as these programs progress toward fielding in the mid 1990s. For example, Industry will eliminate development of duplicative data that drives separate processes in design, manufacturing, support planning, and development of technical manuals, spares provisioning, test equipment, training materials and other support products. Technical data networks among primes/sub-contractors and DoD access to industry data bases will streamline weapon system acquisition and shorten lead times for data delivery and spares procurement. DoD will reduce paper deliverables in contracts and reduce government expenditures for manual processes involving paper handling. Design changes will be consistently promulgated throughout DoD's support structure with assurance that the required technical data will be correctly matched to weapon system configuration. Most importantly, the design of the weapon system and its support systems will have high quality by virtue of integrated design processes and a consistent technical data base. This ultimately translates into increased weapon system effectiveness and combat readiness.

Selected examples of benefits in three primary areas include:

- Automation of Data Acquisition, Preparation and Delivery. Through automation, industry has experienced typical savings of 20-30 percent in technical manual authoring and update processes, and similar savings in generation and revision of engineering drawings using computer-aided design. These savings represent up to $100 million during full scale development of a single major weapon system. Government prototypes of paperless technical manual systems indicate that capturing and delivering this data in digital form will significantly reduce distribution and maintenance costs (Air Force estimates show a potential for $135 million in annual savings). The availability of digital engineering data for competitive spares procurement is expected to provide more complete and accurate data, and to reduce administrative lead times by more than 50 percent. CALS provides the interchange standards and procedures to enable digital file transfer without hard copy generation and repetitive manual entry of the data. Improved accuracy, timeliness and accessibility of data will result.

- Integrated Data Bases. CALS will develop functional specifications for contractor developed and maintained integrated data base systems. Current stand-alone functional processes often involve creating and acquiring the same basic information repeatedly to meet different needs or format requirements. In companies where stand-alone logistics data bases have been interfaced or integrated to eliminate duplication, Integrated Logistic Support (ILS) program savings of 20-25 percent have been projected. ILS normally accounts for about 10 percent of a weapon system development contract. On major weapon system acquisitions this represents savings of over $200 million. Quality improvements are manifested in greater consistency among logistics data products (spares lists, technical manuals, training materials, etc.) and data that matches the latest equipment configuration. In addition, integration of reliability and maintainability analysis with design is helping to develop diagnostic tools that are improving troubleshooting accuracy up to 35 percent, with concomitant cost and readiness payoffs.

- Integration/Redesign of Processes. With on-line access to shared technical data bases, many steps in current government and industry processes can be eliminated entirely, with a substantial reduction in overhead. Preliminary estimates from one CALS technology project indicate that savings of up to 10-20 percent of weapon system life cycle cost can be realized by redesigning processes to take advantage of advanced data base sharing technology in the late 1990s.

## 1.6 FUNDING STRATEGY

DoD and Industry are already making upgrades to their ADP and infrastructure capability. By leveraging these investments, CALS offers an unprecedented opportunity to influence both DoD and Industry business processes for the next five to fifteen years.

### 1.6.1 DoD Funding

The DoD budget for CALS in fiscal year 1989 totals $120 million[1], for two major categories of CALS projects:

- New technology and infrastructure projects initiated directly in response to CALS to facilitate digital data interchange and integration. Program funding of $45 million includes:
  - The OSD program for developing and testing CALS standards and demonstrating digital data integration, access, and delivery.
  - Initiation of the design phase and test bed activities for the Army CALS system which will provide digital interfaces to Industry and integrate current Army islands of automation.
  - Air Force CALS system integration designs.
- Ongoing technology and infrastructure system modernization efforts which have been put under the CALS Steering Group oversight and directly support CALS objectives. Program funding of $75 million includes:
  - Technology programs to demonstrate potential solutions to CALS problems in product definition, electronic technical manuals, reliability and maintainability integration, or parts data access ($51 million).
  - Infrastructure systems to automate engineering drawing repositories, other product data systems, automated publishing and technical manual management systems ($24 million). These systems have made commitments to incorporate CALS interchange standards.

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1 Last year DoD reported a FY 1989 budget projection of $218 million for 60 projects. Due to refinement of scope, this list of projects has changed; three large infrastructure programs (budgeted at $75 million in FY 1989) and several smaller projects have been removed from CALS Steering Group oversight. On a project by project basis, CALS funding has not suffered any disproportionate reductions to meet DoD budget constraints.

Under the DoD CALS Steering Group, technology and infrastructure system modernization programs are being coordinated to get the maximum return from the DoD investment. The CALS investment is enabling data interchange and access among contractor teams, as well as interchange between contractors and DoD. Thus, the CALS projects are leveraging both the multi-billion dollar DoD plans in overall infrastructure modernization and an even larger investment by Industry in their information and automation systems.

### 1.6.2 Industry Investment

The CALS program strategy is encouraging Industry investments in integrated processes on a productivity basis to meet design, manufacturing and data generation requirements and to respond to specific weapon system modernization programs. Incentives to accelerate Industry modernization include CALS requirements in competitive weapon system acquisitions and government funding for Independent Research and Development (IR&D) and Industrial Modernization Improvement Program (IMIP).

# COMPUTER-AIDED ACQUISITION AND LOGISTIC SUPPORT (CALS)

## 2. CALS STATUS, PLANNING AND COMPONENT PROGRAMS

### 2.1 INTRODUCTION

DoD and Industry working groups are jointly defining the technical approach and plans required to evolve from current paper-based operations to full CALS capabilities in an integrated digital environment. This planning will be further documented in an updated CALS Master Plan in Fall 1988.

Since the last report, there have been major achievements in CALS standards development and testing, technology development and demonstrations, preparing for weapon system contract implementation, and DoD systems planning and modernization. These achievements could not have been completed without the continued, active support of Industry. Figure 3 indicates the major milestones within the four key segments of the CALS strategy. Succeeding sections of this chapter describe the planning and progress to date for each segment.

### 2.2 CALS STANDARDS

Standards provide the common interface needed for DoD Components and Industry to interchange and efficiently use digital data. CALS Phase I standards are adaptations of existing and emerging national and international standards. Several significant milestones were met during the past year with publication of the initial series of CALS standards and establishment of a testing network. In addition, planning continued for future standards development and publication. Phase II standards will require additional technology research and development.

Developing and publishing standards is only the first step toward routine contractual use and the ability of DoD to transmit and accept digital technical information. Other steps include development of conformance tests, user end-to-end testing, and incorporation in infrastructure systems. These steps will be taken in parallel with trial contractual implementation, but will not be completed until the mid 1990s to support full implementation.

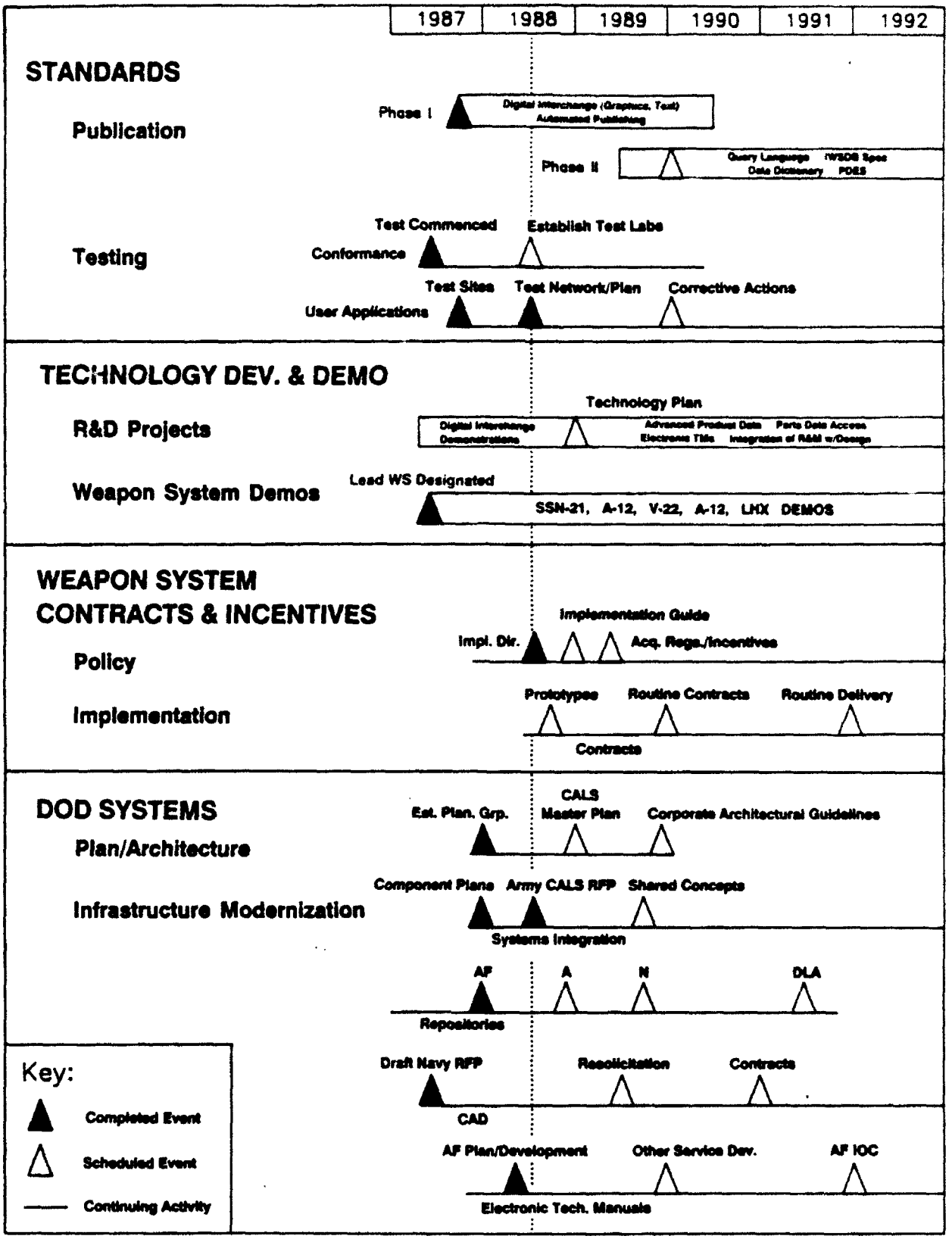


FIGURE 3. CALS MAJOR MILESTONES

### 2.2.1 Standards Published

During the past year DoD developed, coordinated and published the initial set of CALS Phase I Standards for digital interchange of technical information:

- MIL-STD-1840A, "Automated Interchange of Technical Information"
- MIL-D-28000, "Digital Representation for Communication of Product Data: IGES Application Subsets"
- MIL-M-28001, "Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text"

These three standards and specifications enable the digital delivery of engineering drawings and technical manuals, the two largest categories of contract data deliverables. Two additional specifications are currently in coordination for December 1988 publication. They implement industry standards for raster scanning and vector illustrations, and are essential to efficient interchange of graphics data. Published and planned CALS standards are described in Appendix A.

### 2.2.2 Standards Testing

The National Bureau of Standards is developing the necessary conformance tests needed to evaluate vendor compliance with CALS Standards as they are published. However, conformance tests are only the first level of testing required to assure that digital data exchange standards adequately support user requirements for end-to-end data transfer and provide the necessary feedback for standards update. As testing and prototype implementation take place, planning for DoD and Industry infrastructure modernization continues. The sequence of the steps for implementation of standards is illustrated in Figure 4.

OSD has designated the Air Force as lead Service in creating a DoD and Industry distributed test bed network for comprehensive testing of the CALS standards in user applications. By linking existing test beds in DoD and Industry, the investment in the network will be minimized. One node is the Army CALS test bed, which has published its initial evaluation of vendor tools to support the CALS standards. The CALS Test Network will establish a data base of evaluation results and a corrective action review board to follow up on recommendations for improved standards and vendor implementation. Testing of user effectiveness between contractors and DoD Components will also be accomplished when

digital data exchange is made in lieu of hard copy transmission of technical data. A test plan identifies test participants, testing scope and schedules. Initial testing of data exchange standards begins in Fall 1988.

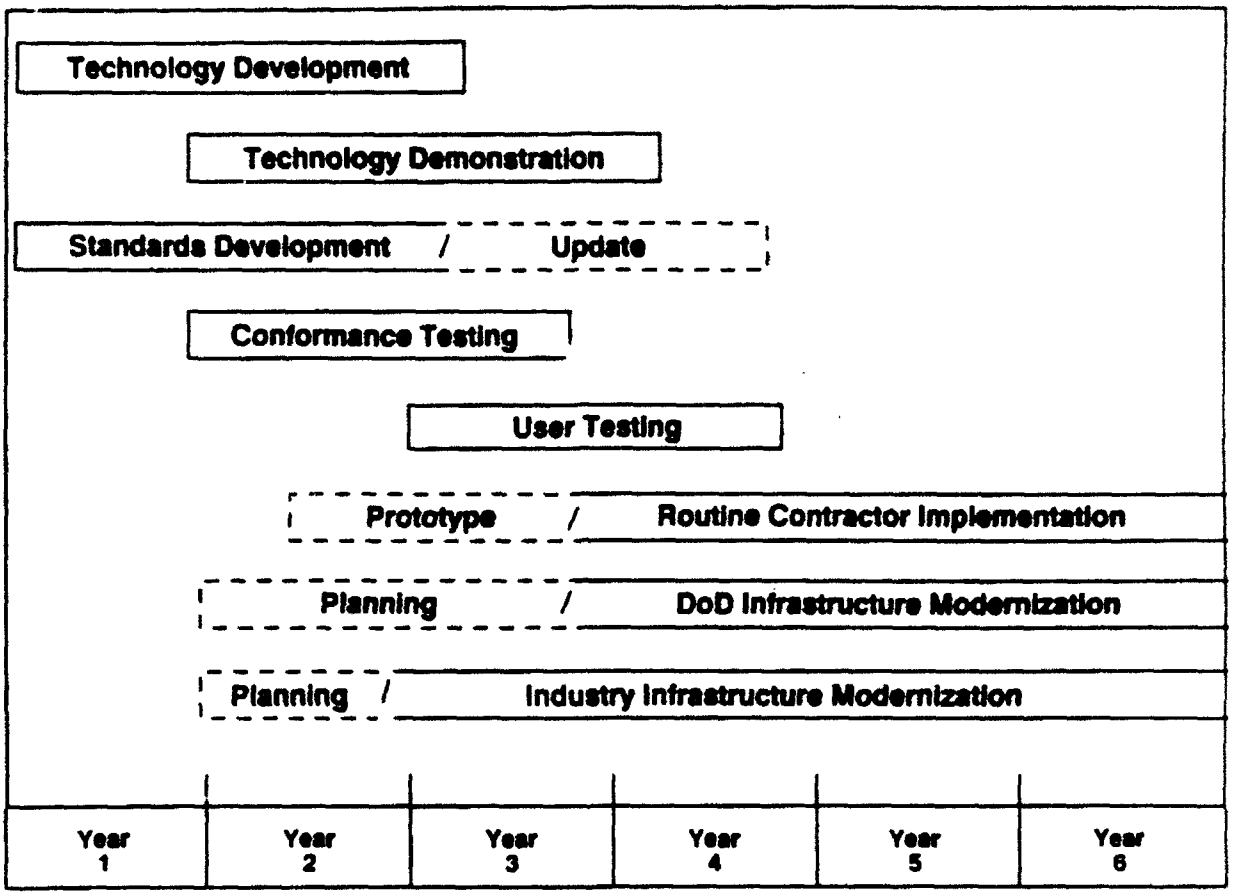


FIGURE 4. CALS STANDARDS IMPLEMENTATION STEPS

### 2.2.3 Future CALS Standards

Future standards preparation will address government and contractor needs for data interchange in terms of both technical data elements and the life cycle functional applications that use technical data.

2.2.3.1 Technical Data Base. The long-term goal of CALS is the development of an Integrated Weapon System Data Base (IWSDB) which incorporates digital engineering product data and logistic support data into a shared, distributed data base. The IWSDB will provide

rapid availability of information to DoD Components and Industry throughout the lifetime of the weapon system. The two major components of the IWSDB data base are product data and support data. Their planned transition phases and ultimate culmination in the IWSDB are illustrated in Figure 5.

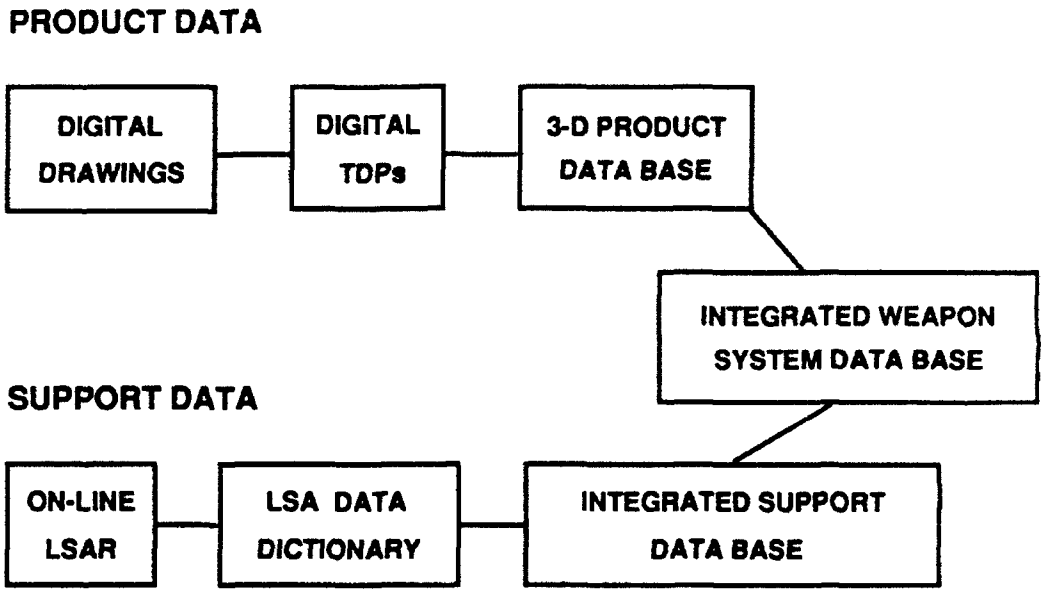


FIGURE 5. TRANSITIONAL PLAN FOR THE IWSDB

Product Data. The technical information relating to parts, assemblies and subsystems used to describe a weapon system for design, analysis, manufacture, test, inspection and reprocurement is called product data. The three steps involved in the support of the CALS transitional plan for product data are:

- Converting existing engineering drawings from paper to digitized form.
- Developing the capability to transmit an entire technical data package (TDP) (drawings, bill of materials, process specifications, etc.) in a fully computer-interpretable form.
- Developing a 3-D Product Data Base as specified by the Product Data Exchange Specification (PDES).

PDES will open the alternative for distributed product data bases which are accessible by members of contractor teams and by the government. A major step was taken this year with the formation of an industry-funded cooperative venture (PDES, Inc.). The objective of this cooperative is to develop pragmatic PDES specifications for initial operational use in 1990.

**Support Data.** The evolutionary path for support data begins with definition of procedures to provide on-line access to existing contractor Logistic Support Analysis Record (LSAR) data bases defined in MIL-STD-1388-2A, "Logistics Support Analysis Record". The 607 LSAR data element definitions provide the starting point for development of a standard model for data base structures and an integrated support data base (ISDB) dictionary that can be merged with an integrated product data model that PDES will specify. This will form the specification for the initial Integrated Weapon System Data Base (IWSDB) in the early 1990s. This distributed data base will support a full range of life cycle applications as shown in Figure 6.

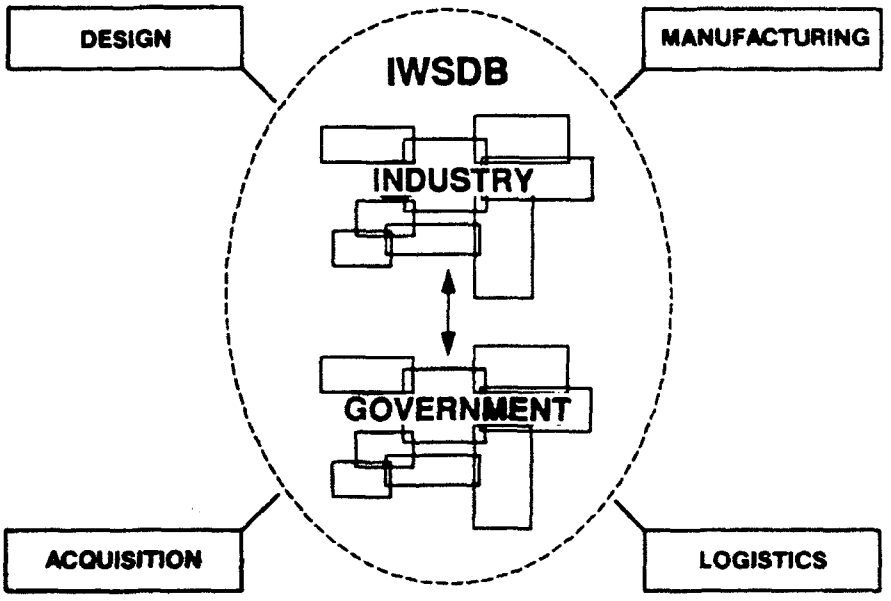


**FIGURE 6. INTEGRATED WEAPON SYSTEM DATA BASE**

2.2.3.2 Applications. The CALS target for the 1990s is for digital data interchange and data base access to support a wide

range of design, manufacturing and support applications within both DoD and Industry. Examples include:

- Computer-aided Design
- Design Analysis
- Manufacturing Process Planning
- Computer-integrated Manufacturing
- Supportability Analysis
- Maintenance Planning
- Technical Manual/Training Material Authoring
- Paperless Maintenance Aids
- On-line Provisioning
- Automated Spares Procurement/Reprocurement

The CALS approach is to impose interface and access standards, but to leave development of the applications to the users. Technical manuals are the first application area to be addressed. The development of automated technical manuals starts with digital input to DoD automated publishing systems (supported by current CALS standards), followed by paperless presentation to the end user, and ultimately to interactive maintenance aids that provide expert troubleshooting assistance. Air Force prototypes indicate that troubleshooting accuracy can be improved by 35 percent in this environment.

Plans for application in additional areas such as training, spares acquisition, and configuration management are being developed in 1988 by DoD and Industry work groups.

2.2.3.3 Plans for CALS Standards. Based on these planned evolutionary stages for source data and applications, the standards development effort at the National Bureau of Standards has been mapped out through 1990. The annual standards publication objectives are shown in Figure 7.

However, publication of a standard is only the first step toward routine contractual implementation as shown in figure 4. Approximately two years of standards testing will be required, during which prototype implementation will occur and contractual requirements for future data delivery will be negotiated.

| | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|
| **Product Data** | Engineering Drawings<br>• Raster<br>• Vector (2 IGES Subsets) | Engineering Drawings (Additional IGES Subsets) | Standards for Electronics<br>Full Digital Data Package<br>Contractor-Maintained Data Base | PDES |
| **Support Data** | Online Access to LSAR (Contractor Specific) | SOW Language to Integrate R&M with LSAR | Initial Data Dictionary and Query Language Standard<br>Functional Std. for ISDB Application Interface (LSA, R&M, Provisioning, TM Authoring) | Expand Data Dictionary to be Compatible with PDES |
| **Technical Manuals** | Digital Capture for Auto. Publishing<br>• SGML Tags<br>• 1 TM Format<br>• Raster Graphics<br>• Vector (1 IGES Subset) | Digital Capture<br>• Addn'l TM Formats<br>• CGM Graphics | Paperless TM's<br>• Functional Std. for Authoring<br>• Interface Std's (SGML, CGM, Raster)<br>• Initial Paperless Delivery | Integrated Maint. Aid<br>• Interface with Weapon System<br>• Functional Std. for "Intelligent" Maint. Assistance |

FIGURE 7. INCREMENTAL CALS STANDARDS RELEASE

## 2.3 TECHNOLOGY DEVELOPMENT AND DEMONSTRATIONS

CALS is coordinating major DoD technology research, development and demonstration programs that support CALS objectives and provide a transition from Phase I to Phase II. These technology programs are focused in several key areas which include advanced product data technology, electronic technical manuals and orders, integration of Reliability and Maintenance (R&M) with design, and gateway access to parts data bases. Appendix B briefly describes the projects in each category. The coordination approach and demonstration objectives in each category are discussed in Section 2.3.1.

### 2.3.1 Research and Development Projects

2.3.1.1 Advanced Product Data Technology Projects. Projects in this category are essential to the development and demonstration of PDES. Key issues include development of a neutral representation of product data for use by dissimilar computer-

aided design, engineering and manufacturing systems; demonstration of computer integrated manufacturing process planning applications; capture of data base information for reprocurement or replacement of electronic parts; and distributed data base access and update. DoD sponsored projects in this category are being coordinated and focused by the Government PDES Users Group to complement the efforts of the industry-funded cooperative venture (PDES, Inc.).

Data security is a significant issue in the area of technical data exchange. CALS technical data requires various levels of security protection, and raises sensitivity and security considerations when technical data is aggregated in shared digital data bases. Security issues are being addressed by a DoD/Industry working group, which is preparing CALS security implementation guidance to be released in 1989. Current indications are that Phase I digital file interchange can be handled with existing security procedures. Solutions for CALS Phase II security requirements and techniques are being pursued by both Government and Industry organizations. CALS planning provides for insertion of new data security technology as part of Phase II implementation in 1991 and beyond.

2.3.1.2 Electronic Technical Manuals/Orders. Each Service has initiated projects to explore alternative technologies for automated preparation and paperless transmission of technical manual data. Key objectives include evaluation of authoring, scanning, and indexing approaches; data base design; portable delivery device designs; interface standards; alternative storage and transmission media; page-oriented versus "pageless" presentation; and user capabilities such as graphic technical instructions, intelligent diagnostics, battle damage assessment aids, computer-aided training lessons, reporting maintenance actions and ordering parts from supply.

Coordination of projects in this category is currently being accomplished by the DoD CALS Steering Group. Service technology projects are being reviewed against the Air Force system architecture for technical orders. This architecture defines functions such as authoring, wholesale distribution, publishing (paper), data base libraries, and user presentation devices. Upon completion of a review this summer, the DoD CALS Steering Group will assign follow-on coordination responsibility for projects in each functional area to avoid unnecessary duplication and to ensure that the minimum number of projects is brought forward for implementation. These plans will be documented in the CALS Technology Plan in December 1988.

Technology is also being explored for application to the development, generation, preparation and production of instructional materials for both computer and non-computer

delivered training courses. Coordination of technology projects in this area is being accomplished through the CALS DoD/Industry Work Group which will develop recommendations on training materials by December 1988.

2.3.1.3 Integration of Supportability with Design. The integration of Reliability and Maintainability with design is a major CALS initiative to improve weapon system supportability. Success depends upon interfacing automated tools with both product data and operational feedback data to affect new design. A joint DoD/Industry work group has evaluated technical and management approaches to this problem, and published recommendations for DoD implementation. This is part of a larger concern for designing quality into new products. Coordination of R&D projects is being accomplished through a joint DoD/Industry study of "Concurrent Engineering" sponsored by OSD and hosted by the Institute for Defense Analyses. Recommendations from this study are due by December 1988.

2.3.1.4 Parts Data Access. The technology for accessing distributed DoD and Industry parts data is becoming available in the form of gateway processors. The key objective is to demonstrate the utility of on-line access in user applications such as Industry access to Government baseline data on standard parts; expert system assistance to users in the selection and querying of DLA technical information databases; and linking data from distributed data bases to determine item availability, identify item sources, and provide technical and manufacturing information. Coordination of projects in this area is being accomplished by a work group on Parts Data Access chartered by the CALS Steering Group and Chaired by the Office of the Deputy Assistant Secretary of Defense (Logistics).

### 2.3.2 Weapon System Demonstrations

Several programs have already begun trial application of CALS technologies and integration approaches. CALS pilot programs include the A-12, ATF and LHX aircraft (coordinated under the Joint Logistics Commanders), the SSN-21 submarine, and the V-22 aircraft. These programs provide demonstrations of data integration, on-line government access to contractor maintained data bases and digital data interchange, as described in Appendix C. Successfully demonstrated approaches will be used on these programs and others in the early to mid 1990s. Additional CALS applications are being planned on such programs as Joint Tactical Fusion, the Mine Countermeasures ship, and the B-2 bomber. More near term applications are being considered. The experience gained in these programs will significantly influence future routine contractual implementation of CALS.

## 2.4 WEAPON SYSTEM CONTRACTS AND INCENTIVES

The incorporation of CALS standards and integration requirements in competitive contracts is viewed by Industry as essential to stimulate needed investments. Starting this year, CALS requirements for integration of contractor technical data systems, authorized government access to contractor data bases, and digital delivery of data using CALS standards will be implemented in contracts that will deliver data in the early 1990s and beyond.

### 2.4.1 Implementation Policy

Recent policy guidance issued by the Deputy Secretary of Defense requires that:

- Systems now in full scale development or production be reviewed for opportunities to improve quality or reduce costs by changing to digital delivery or access.
- Systems entering development after September 1988 obtain competitive proposals for contractor integration, on-line government access to data, and digital data interchange.
- DoD Components program resources for automated systems to receive, store, distribute, and use digital data for weapon system acquisition and logistic support.
- The Under Secretary of Defense (Acquisition) issue further guidance on contract requirements, application to subcontractors and small business, incentives and funding mechanisms.

### 2.4.2 CALS Implementation Guide

In April 1988, MIL-HDBK-CALS, "CALS Implementation Guide" was released for coordination. The purpose of this guide is to aid managers in contracting for digital delivery of data products and integration of contractor processes. It provides model contractual requirements for digital data integration, access and delivery, and decision guidance regarding alternative modes of data delivery. It will be expanded to cover additional functions as part of the planned incremental releases of the CALS standards and specifications.

The guide is a necessary element for training, implementation and continued extension of CALS requirements in DoD weapon system acquisition. Based on this guide, a training module in the Defense System Management College Program Managers Course is being developed for use starting in Fall 1988.

### 2.4.3 Experience In Early Application

Implementation of CALS requirements and standards poses a significant technical and cultural change in the manner in which DoD and Industry design, manufacture and support weapon systems. Significant "growing pains" are to be expected during this transition. CALS has recognized the need for a program to provide early feedback on CALS implementation to minimize problems. The results of standards testing in user applications, weapon system demonstration and early weapon system prototype implementation will provide the necessary feedback to take appropriate corrective actions and ensure effective transition to routine digital delivery in the early 1990s.

## 2.5 DoD SYSTEMS

To receive or access digital technical data, and use it efficiently in weapon system life cycle support functions, DoD needs to modernize and integrate the systems in its infrastructure. Three planning and management tasks are important to CALS success in this regard.

- The major groupings of functions, data flows, systems and interfaces must be identified -- that is, defining the major pieces of the process, how they fit together, and where gaps exist. At the top level, this process will be addressed by DoD's Logistics ADP Modernization Plan, of which CALS is an important subset. Successive levels of analysis and planning are the responsibility of the OSD and Component CALS offices, and are discussed in paragraph 2.5.1.

- When existing DoD systems must interface with one another and/or with Industry, CALS standards need to be incorporated. The DoD CALS Office has the responsibility for providing the interface standards and implementing guidance. The DoD Components are responsible for modifications to existing information systems. Progress is reviewed by the DoD CALS Steering Group.

- Where gaps in capability are identified, new infrastructure information system acquisitions or major modifications must be undertaken. The DoD CALS Steering Group is responsible for providing coordination and guidance to ensure that there is no unnecessary duplication among DoD Components' CALS acquisitions. Oversight of individual ADP acquisition programs is provided by the Major Automated Information System Review Council (MAISRC) or the equivalent Component review council. The DoD CALS Office advocates funding and management priority for these acquisitions, and reviews compliance with CALS interface standards and integration requirements.

Program management of individual systems is assigned to organizations within each Component. The infrastructure programs that are critical to DoD CALS implementation are listed in Appendix D.

### 2.5.1 Architecture Planning

During the last year, OSD has led the Components in a series of planning sessions to more clearly define the scope of CALS and coordinate ongoing programs. Planning sessions over the next year will continue to define areas where corporate DoD solutions are needed as distinguished from those where Component-specific solutions are appropriate. To support this effort, a top level functional review of each Component's programs and processes that relate to CALS has begun, using a formalized systems architecture development approach. This approach will define corporate elements of the CALS "system of systems" in terms of the required data, the functions, and the network architecture. Architectural guidelines based on this structured approach will be available in June 1989, and will address elements critical to CALS Phase II, such as the indexing and locator system for accessing data in a highly integrated, but geographically distributed, data base environment. These elements will be corporately developed to insure consistent CALS implementation within DoD and Industry.

Each Service and DLA has initiated planning and integration efforts to define the needs and technical approach for connectivity among systems in their separate infrastructures. The Army CALS (ACALS) program is the largest of these efforts, and includes conceptual system design (architecture), technical demonstration, concept development and fielding of a digital system capable of receiving, storing, processing, disseminating and using weapon system acquisition and logistic technical information. As the ACALS concept is developed, selective elements within its architecture design will be evaluated as a prototype for CALS architectures throughout DoD. The DoD MAISRC Milestone 0 review was conducted in May 1988 and approval to proceed with concept development was granted. System hardware procurement is planned to begin in FY91.

### 2.5.2 Infrastructure Modernization

The DoD Components have undertaken a wide range of projects for modernizing and improving their infrastructures. Major areas of activity are automation and integration of engineering drawing repositories, computer-aided design systems, technical manuals and communication systems. The projects that are the focus of joint Service and DLA review are discussed in the following paragraphs.

2.5.2.1 Engineering Drawing Repositories. The effort to automate all DoD engineering data repositories with interoperable capabilities is progressing rapidly. The jointly developed and acquired Army/Air Force repository system (DSREDS/EDCARS) is now operational at all Air Force sites and repository installations at Army sites have begun. The Navy/DLA joint repository project (EDMICS) is in the procurement process. DLA is also developing a DoD-wide system for locating engineering drawings in DoD repositories; their Military Engineering Data Asset Locator System (MEDALS) will be fully operational by October 1989. To extract technical data packages from the automated repositories, the Army's Technical Data Configuration Management System (TD/CMS) is being explored as the basis for a common system procedure to be used by all data repositories.

2.5.2.2 Computer-Aided Design. A Computer-Aided Design (CAD) system acquisition is being planned by the Navy. Requirements are being developed to procure commercially available work stations which will be capable of interface with the engineering drawing repositories. OSD has directed the other Components to review their requirements for CAD systems and participate in this contract.

2.5.2.3 Electronic Technical Manuals/Orders. Although each Service has prototype efforts to explore technologies for the generation and maintenance of technical manuals/technical orders and other technical information, only the Air Force has programmed a comprehensive infrastructure modernization program for electronic technical orders. The Air Force Technical Order Management System (AFTOMS) will provide digital receipt of technical orders, as well as distribution to users and updates as changes are required. This program will build on the current Automated Technical Order System (ATOS) baseline, and provide significantly more capability to the ultimate users of technical orders at base level. Until AFTOMS implementation, ATOS will continue to accommodate paper-type technical orders through scanning and maintaining digital storage of technical orders.

The AFTOMS concept for wholesale/depot level management of digital receipt, archiving, cataloging, distribution and change management will also apply to applications for the Army and Navy. Using the Air Force concept as a building block, the other services are developing the initial concepts to fully integrate the entire technical manuals process within their organizations.

2.5.2.4 Communication Systems. On-line transmission of the full volume of technical data for major weapon systems is beyond the economical capability of current communication networks in DoD and Industry. In the near term, CALS will accomplish bulk data transfers of engineering drawings, technical manuals and other voluminous documents via physical media, such as tape or optical

disk. On-line interaction will be used primarily for lower volume transaction processing and data base access where operational requirements dictate and it is economically prudent. The long range plan is to employ cost effective, secure high speed data communication network capabilities (both commercial and Defense Data Network upgrades) which are expected to be available in the future. Studies are underway to identify the most effective and efficient means for digital data transmission and communication. Individual CALS program requirements will be thoroughly addressed in design trade-offs conducted during infrastructure modernization program reviews.

## 3. CONCLUSION

The CALS program has made significant progress during the past year. Technical information exchange standards have been published, a standards application testing program has begun, and the incorporation of CALS concepts into DoD and industrial infrastructures is underway. Advanced technology research and development to meet long term CALS requirements is being accelerated through close DoD and Industry collaboration. Initial weapon system applications are being demonstrated and the implementation policy creates the impetus for routine contractual implementation on weapon system contracts.

CALS provides a unique opportunity to achieve major productivity and quality improvements through carefully planned and managed investment by both Government and Industry. Planning efforts are concentrating on the orderly insertion of technological advances in digital technical data management and use into the existing defense acquisition and logistic support process. Most importantly, the ability of the Defense Components to perform their assigned missions will continue during this technology insertion process.

As the cumulative impact of CALS implementation is experienced through the process of infrastructure modernization in DoD and Industry, major savings will occur as DoD and Industry incorporate more far-reaching functional changes made possible by information integration. These changes represent the ultimate goal of CALS implementation and will result in a lower weapon system life cycle cost, shortened acquisition times, and improvements in reliability, maintainability and readiness.

# APPENDIX A

# CALS STANDARDS AND SPECIFICATIONS

## APPENDIX A

## CALS STANDARDS AND SPECIFICATIONS

### BACKGROUND

The creation of a unified DoD/Industry interface, whether through exchange of digital data files between linked data systems, or through access to distributed data bases, requires common definition of data interchange and access rules. This is the purpose of the CALS standardization effort. Standards can be divided into several basic categories:

- Functional requirements standards define information and capabilities required by DoD, such as the content and scope of a technical manual. They are developed by functional managers, not by the CALS program.

- Data interchange standards, developed by DoD and Industry through the CALS program, provide common rules for digital interchange of technical information. CALS Phase I focuses on this category of standards. It includes standards already adopted (or currently in the process of adoption), those for which development work is underway, and those which have been recommended for future consideration.

- Data management and access standards, also developed by DoD and Industry through the CALS program, will provide common definitions of the data elements, their attributes, relationships, data integrity constraints, and access rules needed for an Integrated Weapon System Data Base. CALS Phase II focuses on this category of standards.

- Communication protocols permit networks of computers to interoperate directly without the use of physical media such as magnetic tape, when the necessary data interchange and access standards are in place. Communication protocols are being developed by functional specialists such as the Defense Communications Agency, not by the CALS program.

- Application guidance developed by the CALS program assists acquisition managers to understand when, where, and how to apply standards efficiently to support their information interchange and access requirements, and how to define their functional requirements for integration of the contractor processes that create and use that information.

CALS standards are implementations of existing or emerging national and international industry standards. The CALS standards define unambiguous implementations of these industry standards that meet the technical requirements of DoD and the defense industry in the most efficient manner possible.

## INITIAL CALS STANDARDS AND APPLICATION GUIDANCE

The CALS standards and specifications are being developed incrementally. The initial increment, called the Phase 1.0 Core Requirements package, was developed and coordinated during 1987. The 1988 increment, called the Phase 1.1 Core Requirements Package, has been released for formal DoD and Industry coordination and will be published by December 1988. Development of the Phase 1.2 standards and specifications is underway for coordination during 1989. Documents released to date include:

MIL-STD-1840A, "Automated Interchange of Technical Information." (December 22, 1987) MIL-STD-1840A is the parent document for the other CALS standards and specifications. It provides rules for organizing files of digital data into a complete deliverable document, using the supporting CALS military specifications -- MIL-D-28000 for IGES product definition data, MIL-M-28001 for SGML text data, MIL-D-CGM for vector illustration data, or MIL-R-RASTER for raster illustration data.

MIL-D-28000, "Digital Representation for Communication of Product Data: IGES Application Subsets." (December 22, 1987) MIL-D-28000 defines a series of application-specific subsets of the Initial Graphics Exchange Specification (IGES), the popular name for American National Standard ANSI Y14.26M, "Digital Representation for Communication of Product Definition Data."

MIL-M-28001, "Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text." (February 26, 1988) MIL-M-28001 defines standard DoD requirements for automated publishing of page-oriented (i.e., printed) technical manuals and technical orders. It defines a common DoD-wide implementation of International Standard ISO 8879, "Information Processing - Text and Office Systems - Standard Generalized Markup Language (SGML)." It also defines typographic tags and format rules for document composition, and options for use of commercial page description language products.

MIL-D-CGM, "Digital Representation for Communication of Illustration Data: CGM Application Profile." (Draft) MIL-D-CGM defines an application profile for delivery of technical manual illustration using the Computer Graphics Metafile (CGM). CGM has been published as International Standard ISO 8632, American National Standard ANSI X3.122, and Federal Information Processing Standard FIPS 128.

MIL-R-RASTER, "Requirements for Raster Graphics Representation in Binary Format." (Draft) MIL-R-RASTER defines engineering drawing and technical manual illustration requirements for raster graphics compressed in accordance with International Standard CCITT T.6, "Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus," and FED-STD-1065.

MIL-HDBK-CALS, "CALS Implementation Guide." (Draft) MIL-HDBK-CALS is a military handbook that provides guidance to acquisition managers who have responsibility for preparing contract requirements addressing (1) digital delivery or access to weapon system technical information, and (2) functional requirements for integration of contractor processes that create and use technical information. This includes:

- A description of the integrated, shared data environment toward which CALS is targeted, and guidance on the contractor proposals and plans for creating and using such an environment as required by the government.

- Guidance on the acquisition of digital data for:
  - Technical manuals
  - Technical data packages, including engineering drawings, specifications, and book-form drawings
  - Logistic support analysis record data
  - Training materials

- Guidance on requesting contractor proposals to improve weapon system reliability and maintainability (R&M) through integration of R&M with computer-aided design and engineering.

## WORK IN PROGRESS

Work now underway to define CALS Phase 1.2 and Phase II Core Requirements will broaden the application environment for the current CALS standards, and in selected cases define requirements for additional digital data interchange and access standards. Examples include:

- The Office Document Architecture and Interchange Format (ODA/ODIF) for presentation and layout, and the Standard Page Description Language (SPDL) for image delivery, of technical publications

- Various additional candidates for exchange of product definition data for electronics, such as the Electronic Data Interchange Format (EDIF), the VHSIC Hardware Description Language (VHDL), and the Integrated Printed Circuit (IPC) standards

- The Information Resource Dictionary System (IRDS) for management of data element definitions and their relationships, and the Structured Query Language (SQL) for data access

- The Product Data Exchange Specification (PDES) which will encompass the complete set of data elements that defines a product for all applications over its expected life cycle.

The work to develop CALS implementations of these current and future industry standards is being accomplished jointly by DoD, by the National Bureau of Standards (NBS), and by industry users and vendors. This same community is working to develop a comprehensive testing program that will assure that the CALS standards are being correctly implemented, that computer products of different vendors will work together, and that these standards will satisfy the information interchange and access requirements of the functional managers who must rely upon them. Product conformance tests and test procedures are being developed or coordinated by NBS, with CALS support. CALS has established a distributed CALS Test Network to accomplish functional user application testing. The network will include nodes within DoD, such as the Army CALS test bed, and nodes at selected defense contractor sites. Through testing, trial contractual applications, and technology development and demonstration, CALS will ensure that its implementations of national and international standards fully meet the needs of DoD and the defense industry.

# APPENDIX B

# CALS TECHNOLOGY DEVELOPMENT AND DEMONSTRATION PROJECTS

## APPENDIX B

## CALS TECHNOLOGY DEVELOPMENT AND DEMONSTRATION PROJECTS

An important part of the CALS strategy is to evaluate alternative technology approaches prior to committing to full scale implementation. The following technology development and demonstration projects contain a number of promising approaches which are being considered for CALS implementation. They supplement information contained in Section 2.3.1 of this report. A technology plan will document key technologies and schedules which are critical to CALS implementation.

### 1. Advanced Product Data Technology (Projects being coordinated by Government PDES Users Group)

| ACRONYM | ORG | TITLE | DESCRIPTION | IMPORTANCE TO CALS |
|---|---|---|---|---|
| IISS | AF | Integrated Information Support System | IISS is providing (1988) transparent interface to the user regardless of computer or communications equipment brands or data base types being used by the Government and Industry. It was successfully demonstrated in a test bed environment and is now ready to transition the results to implementation. | Candidate technical approach for CALS Phase II |
| GMAP | AF | Geometric Modeling Application Interface Program | An engine manufacturer and an Air Logistics Center are installing the GMAP product definition data interface software as the next step (1988) in demonstrating the communication and manipulation of geometric and non-shape data for engineering, manufacturing, and logistics support of complex structured components. | A starting point for PDES implementation |

## CALS TECHNOLOGY DEVELOPMENT AND DEMONSTRATION PROJECTS (continued)

| ACRONYM | ORG | TITLE | DESCRIPTION | IMPORTANCE TO CALS |
|---|---|---|---|---|
| IDS | AF | Integrated Design Support System | A heterogeneous computer system will be placed in operation (1988) to validate the concept for integrated logistics data bases including engineering data from the design process. | Candidate technical approach for CALS Phase II |
| MCM | N | Mine Countermeasures Ship Data base | Developing specifications (1988) for product modeling that integrates a 3D graphic solid presentation with other logistics and analytic files, providing a complete data set for a weapon system. | Candidate technical approach for CALS Phase II |
| DGIS | DLA | DoD Gateway Information System | Create an expert system based common command language (1990) for identifying, retrieving, and analyzing technical bibliographic information in heterogeneous databases through an on-line gateway. | Candidate technical approach for access to distributed data bases |
| RAMP | N | Rapid Acquisition of Manufactured Parts | Develop and demonstrate (1990-1991) computer integrated manufacturing technology to produce low volume spare parts on demand. Technologies include adaptive process control software, robotics, electronic parts technical data interchange. | Gain early experience using CALS product data standards in paperless manufacturing and serve as PDES test bed |

## CALS TECHNOLOGY DEVELOPMENT AND DEMONSTRATION PROJECTS (continued)

| ACRONYM | ORG | TITLE | DESCRIPTION | IMPORTANCE TO CALS |
|---|---|---|---|---|
| EIS | AF | Engineering Information System | EIS will develop a set of standards for computer-aided engineering (CAE) and demonstrate (1990) their functionality and utility. | Candidate CALS standards for electronic product data |
| MEP | DLA | Microcircuit Emulation Program | Establish a capability (1990) to emulate microcircuits so that form, fit and function replacement parts can be produced on demand for otherwise out-of-production microcircuits. | Definition of product data CALS needs to capture for life cycle support |

## CALS TECHNOLOGY DEVELOPMENT AND DEMONSTRATION PROJECTS (continued)

2. Electronic Technical Manuals/Orders and Training Materials (Projects being coordinated by the CALS Steering Group)

| ACRONYM | ORG | TITLE | DESCRIPTION | IMPORTANCE TO CALS |
|---|---|---|---|---|
| IMIS | AF | Integrated Maintenance Information System | Develop capability to provide all information needed by a base level maintenance technicians using portable computer terminals to interface with aircraft maintenance panels and ground-based computers. Will be prototyped (1992). In AFTOMS architecture for AF Infrastructure. | Candidate technical approach for advanced interactive maintenance aids |
| NTIPS | N | Navy Technical Information Presentation System | Developed and demonstrated (1987) display devices and related software to present technical information in electronic form for operation, installation and maintenance technicians. Raster scanning of technical manuals for a digital library with retrieval in page or task-tailored packages from portable delivery devices. | Candidate technical approach for paper-less technical manuals |
| CBAT | N | Computer-Based Aid for Trouble-Shooting | Design electronic presentation techniques to ensure all troubleshooting information is accessible to the technician during corrective maintenance (1991). | Candidate technical approach for interactive maintenance aids |
| SMDP | DLA | Standardized Military Drawing Program | Provide (1990) the capability to create and modify the drawings for military specification standardization to support electronics parts reprocurement. | Gain early experience with CALS standards for vector drawings |

CALS TECHNOLOGY DEVELOPMENT AND DEMONSTRATION PROJECTS (continued)

| ACRONYM | ORG | TITLE | DESCRIPTION | IMPORTANCE TO CALS |
|---|---|---|---|---|
| AIM | N | Authoring of Instructional Material | Provide a state-of-the art automated authoring system (1990) that permits subject matter experts to design, develop, produce, and maintain high quality, standardized instructional materials tied to job performance requirements. | Candidate technical approach for automated authoring |
| MEIDS | A | Militarized Electronic Information Delivery System | The proof-of-principle design analysis will be demonstrated (1988) for a hand-portable, self-contained and interactive electronic information delivery system for technicians in the field. | Candidate technical approach for paperless delivery device |
| ITDS | AF | Improved Technical Data System | Operational support of a weapon system will be provided (1990) by a state-of-the-art electronic technical data system. Planned for implementation on B-2 aircraft. | Candidate technical approach for paperless technical manual display. |
| CATIS | N | Computer-Aided Technical Information System | Conversion of technical library materials to "Functional Bundles" stored on optical media to support ship maintenance and operation and training. Develop (1990) specification and process instructions for packaging, delivery and retrieval of large volumes of digitized text and graphics for use aboard ship and ashore. | Candidate technical approach for digitizing existing technical documentation |

## CALS TECHNOLOGY DEVELOPMENT AND DEMONSTRATION PROJECTS (continued)

3. Integration of Supportability with Design (Projects being coordinated in joint DoD/Industry Review of Concurrent Engineering)

| ACRONYM | ORG | TITLE | DESCRIPTION | IMPORTANCE TO CALS |
|---|---|---|---|---|
| MLCAD | AF | Maintenance and Logistics Factors in Computer-Aided Design | MLCAD is continuing (1987-1991) to explore, test, and disseminate means for incorporating reliability, maintainability and supportability factors in computer-aided design of weapon systems. | Identification of data requirements and interfaces with automated tools in weapon system design |
| UDB | AF/N | Unified Data Base | UDB is an automated on-line (1988) data base for logistics support analysis in compliance with MIL-STD-1388-2A. AF has demonstrated its use on the B-1 and F015E program. UDB was also adopted by the Navy for the SSN-21. | Reduces time/cost of LSA and provides for supportability consideration in design |
| IDSS | N | Integrated Diagnostic Support System | Developing a set of software diagnostic design tools including a testability analyzer, adaptive diagnostic authoring tool and a feedback analysis tool (1990). IDSS is demonstrating the technology to improve organizational level maintenance, and to pass diagnostic information to higher levels of maintenance. Planned demonstrations on Fat Line Towed Array Sonar, V-22, and Phalanx. | Identification of data requirements and interfaces with automated tools in weapon system design |

CALS TECHNOLOGY DEVELOPMENT AND DEMONSTRATION PROJECTS (continued)

4. Parts Data Access (Projects being coordinated by DoD CALS Work Group on Parts Data Access)

| ACRONYM | ORG | TITLE | DESCRIPTION | IMPORTANCE TO CALS |
|---|---|---|---|---|
| GFB | DLA | Government Furnished Baseline | Provide (1988) prototype capability for industry and military activities direct access to the electronic and mechanical parts data bases. | Gain early experience with on-line industry access to government digital data |
| MIDS | A | Materials and parts Information Data System | Demonstrate (1989) the capability to crosslink information at multiple locations for assessing status and exercising control of materials and parts. | Candidate technology for accessing distributed data bases |

# APPENDIX C

# CALS WEAPONS SYSTEM DEMONSTRATIONS

## APPENDIX C

## CALS WEAPON SYSTEM DEMONSTRATIONS

The following weapon systems have been designated as lead systems for early demonstration and implementation of CALS requirements and standards. A brief description of each program supplements Section 2.3.2 of this report.

**IMPORTANCE TO CALS:** Early experience with CALS requirements for contractor integration; on-line access, and digital data delivery using CALS standards.

| ACRONYM | ORG | TITLE | DESCRIPTION |
|---|---|---|---|
| ATF | AF | Advanced Tactical Fighter | Demonstration (1988) of multiple technical data base connectivity and integration for maintenance and provisioning. |
| SSN-21 | N | Seawolf Class Submarine | Demonstrated (1988) the transfer of two and three dimensional digital data between dissimilar CAD systems of both Government and Industry using CALS standards. |
| V-22 | N | Osprey Aircraft | Demonstrated (1988) on-line provisioning, automated generation and on-line access for task and skill analysis and generation of support equipment requirements data in digital form. |
| LHX | A | New Light Helicopter | Competing contractor teams are required to deliver technical data (1992) in compliance with CALS standards; the competing engine design teams have (1988) the capability for on-line LSAR preparation. |
| A-12 | N | Advanced Tactical Aircraft | Incorporates a full CALS program during Full Scale Development. This program will include weapon system data base that integrates CAD, CAM, engineering and logistic analyses and generates drawings, technical manuals, training materials, supply data, and other logistic products in digital form. |

# APPENDIX D

## DoD SYSTEMS

## APPENDIX D

## DoD SYSTEMS

1. **Architecture Planning.** The following modernization programs are implementing CALS concepts and standards for DoD systems. Descriptions supplement information provided in Section 2.5 of this report.

**IMPORTANCE TO CALS:** Development of integration approaches; identification of interfaces needing standards, candidate architecture elements for DoD-wide use; implementation of CALS standards.

| ACRONYM | ORG | TITLE | DESCRIPTION |
|---|---|---|---|
| ACALS | A | Army Computer-aided Acquisition and Logistic Support System | A comprehensive concept design (architecture) is being developed for fielding (1993) a digital system capable of receiving, storing, processing, disseminating and using weapon system logistic technical information for the Army. |
| MIO/ATI | AF | Management Integration Office/Automated Technical Information | A modular planning process developing Air Force architecture for CALS implementation; the technical order automation plan was completed (1988) and work is nearing completion on plans for logistics support analysis (1988) and product definition data (1988). |
| NSTIS | N | Navy Standard Technical Information System | Development (1988) of architecture concepts for coordinating, integrating and implementing Navy CALS and related logistics modernization and automation efforts. |
| LSMP | DLA | Logistics Systems Modernization Program | Integration of CALS requirements is a part of LSMP architecture, planning and concept development. |

## 2. Engineering Data Repositories and Product Data

**IMPORTANCE TO CALS:** Implementation of CALS standards.

| ACRONYM | ORG | TITLE | DESCRIPTION |
|---|---|---|---|
| DSREDS/ EDCARS | A/AF | Digital Storage and Retrieval of Engineering Data System/Engineering Data Computer-Assisted Retrieval System | Jointly developed and procured program to provide engineering drawing repositories (1988) with capabilities for storing, retrieving, updating, and reproducing engineering documentation in digital form. System will be interoperable with EDMICS. |
| EDMICS | N/DLA | Engineering Data Management Information and Control System | A joint Navy and DLA acquisition (1989-1991) of automated engineering drawing repositories with capabilities for storing, retrieving, updating and reproducing engineering documentation in digital form. System will be interoperable with DSREDS/EDCARS. |
| MEDALS | DLA | Military Engineering Data Asset Locator System | Provides an index for, and on-line access to, the location of engineering drawing data in DoD data repositories. (1988). |
| TD/CMS | A | Technical Data/Configuration Management System | The existing technical data/configuration management system is being redesigned on a relational data base management system (1988) to improve capability and provide a standard approach at reduced cost. |
| CAD-2 | N | Computer-Aided Design (Second Acquisition) | Implement (1990) modern CAD technology to improve productivity of ship, air, facilities, electronics and printing/publications missions. Will acquire commercially available state-of-the-art technology CAD systems for all Defense Components. |
| MPCASS | DLA | Modernized Parts Control Automated Support System | Provide (1988) on-line access to parts data (military drawings and specifications) for Military Services and Industry to improve standardization. |

3. **Automated Publishing and Paperless Technical Manuals Systems**

**IMPORTANCE TO CALS:** Implementation of CALS standards.

| ACRONYM | ORG | TITLE | DESCRIPTION |
|---|---|---|---|
| AFTOMS/ ATOS | AF | Air Force Technical Order Management System/ Automated Technical Order System | The Air Force Technical Order Management System (AFTOMS) Program Office has been established (1988) to provide for the infrastructure needed to receive, manage, distribute, and use digital technical orders. The current ATOS is one of the functional modules of the future AFTOMS. |
| NAPS | N | Navy Automated Publishing System | NAPS will integrate technical information data bases (1989) and adopts automated publishing and printing technologies for producing training curricula and technical manuals rapidly on demand (1990-1992). |
| NPODS | N | Navy Print on Demand System | NPODS will automate the DoD specification and standard repository at the Navy Publications and Forms Center (1989). NPODS will conform with CALS data standards and use optical disk and high speed laser printing to eliminate pre-printed shelf stock. |

## GLOSSARY

| | |
|---|---|
| A | Army |
| ACALS | Army CALS |
| ADMAPS | Automated Document Management and Publishing System (Navy) |
| ADP | Automated Data Processing |
| ADVANCE | Army Data Validation and Netting Capability Establisment |
| AF | Air Force |
| AFTOMS | Air Force Technical Order Management System |
| AIA | Aerospace Industries Association |
| AIM | Authoring of Interstructional Material (Navy) |
| ASD(P&L) | Assistant Secretary of Defense (Production and Logistics) |
| A-12 | Advanced Tactical Aircraft (Navy) |
| ATI | Automated Technical Information |
| ATF | Advanced Tactical Fighter (Air Force) |
| ATOS | Automated Technical Order System (Air Force) |
| CAD | Computer-Aided Design |
| CAD-2 | Computer-Aided Design-2nd Acquisition (Navy) |
| CAE | Computer-Aided Engineering |
| CALS | Computer-Aided Acquisition and Logistic Support |
| CAM | Computer-Aided Manufacturing |
| CATIS | Computer-Aided Technical Information System (Navy) |
| CBAT | Computer-Based Aid for Troubleshooting (Navy) |
| CGM | Computer Graphics Metafile |
| DARPA | Defense Advanced Research Projects Agency |
| DASD | Deputy Assistant Secretary of Defense |
| DEPSECDEF | Deputy Secretary of Defense |
| DGIS | DoD Gateway Information Systems (DLA) |
| DLA | Defense Logistics Agency |
| DoD | Department of Defense |
| DSREDS | Digital Storage and Retrieval of Engineering Data System (Army) |

| | |
|---|---|
| EDCARS | Engineering Data Computer-Assisted Retrieval System (Air Force) |
| EDMICS | Engineering Data Management Information and Control System (Navy/DLA) |
| EIA | Electronics Industry Association |
| EIS | Engineering Information System (Air Force) |
| FED-STD | Federal Standard |
| FSD | Full Scale Development |
| FY | Fiscal Year |
| GFB | Government Furnished Baseline (DLA) |
| GMAP | Geometric Modeling Applications Interface Program (Air Force) |
| ICA | Institute of Cost Analysis |
| IDS | Integrated Design Support System (Air Force) |
| IDSS | Integrated Diagnostic Support System (Navy) |
| IGES | Initial Graphics Exchange Specification |
| IISS | Integrated Information Support System (Air Force) |
| ILS | Integrated Logistic Support |
| IMIP | Industrial Modernization Incentive Program |
| IMIS | Integrated Maintenance Information System (Air Force) |
| IOC | Initial Operating Capability |
| IPC | Integrated Printed Circuit |
| IR&D | Independent Research and Development |
| IRDS | Information Resource Dictionary System |
| ISDB | Integrated Support Data Base |
| ITDS | Improved Technical Data System (Air Force) |
| IWSDB | Integrated Weapon System Data Base |
| JLC | Joint Logistics Commanders |
| LHX | Light Helicopter, Experimental (Army) |
| LSA | Logistics Support Analysis |
| LSAR | Logistics Support Analysis Record |
| LSMP | Logistics Systems Modernization Program (DLA) |

| | |
|---|---|
| MAISRC | Major Automated Information Systems Review Council |
| MCM | Mine Countermeasures Ship Database (Navy) |
| MEDALS | Military Engineering Data Asset Locator System (DLA) |
| MEIDS | Militarized Electronic Information Delivery System (Army) |
| MEP | Microcircuit Emulation Program (DLA) |
| MIDS | Materials and Parts Information Data System (Army) |
| MIL-HDBK | Military Handbook |
| MIL-SPEC | Military Specification |
| MIL-STD | Military Standard |
| MIO | Management Integration Office (Air Force) |
| MLCAD | Maintenance and Logistics Factors in Computer-Aided Design (Air Force) |
| MPCASS | Modernized Parts Control Automated Support System (DLA) |
| N | Navy |
| NAPS | Navy Automated Publishing System |
| NBS | National Bureau of Standards |
| NCGA | National Computer Graphics Association |
| NPODS | Navy Print on Demand System |
| NSIA | National Security Industrial Association |
| NSTIS | Navy Standard Technical Information System |
| NTIPS | Navy Technical Information Presentation System |
| OASD(P&L) | Office of the Assistant Secretary of Defense (Production and Logistics) |
| OSD | Office of the Secretary of Defense |
| ODA/ODIF | Office Document Architecture and Interchange Format |
| PALT | Procurement Administrative Lead Time |
| PDES | Product Data Exchange Specification |
| RAMP | Rapid Acquisition of Manufactured Parts (Navy) |
| R&D | Research and Development |
| R&M | Reliability and Maintainability |
| RDT&E | Research, Development, Test and Evaluation |
| RFP | Request for Proposal |

| | |
|---|---|
| SCA | Shipbuilders Council of America |
| SGML | Standard Generalized Markup Language |
| SMDP | Standard Military Drawing Program (DLA) |
| SNAP | Ship Non Tactical ADP (Navy) |
| SOLE | Society of Logistics Engineers |
| SOW | Statement of Work |
| SPEC | Specification |
| SPDL | Standard Page Description Language |
| SSN-21 | SEAWOLF Class Nuclear Attack Submarine |
| SQL | Structured Query Language |
| | |
| TD/CMS | Technical Data/Configuration Management System (Army) |
| TDP | Technical Data Package |
| TM | Technical Manual |
| TO | Technical Order (Air Force) |
| | |
| UDB | Unified Data Base for acquisition logistics (Air Force) |
| USD(A) | Under Secretary of Defense (Acquisition) |
| | |
| V-22 | OSPREY Aircraft (tri-service) |
| VHSIC | Very High Speed Integrated Circuit |
| | |
| WS | Weapon System |